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Elevation of external cusp.....	.065
“ internal “ .....	.055
Length between apices of external cusps.....	.043

The molar tooth described exceeds in transverse dimensions that of the *Mastodon ohioiticus*, and evidently belonged to one of the most colossal of land animals. Its generic position is near to *Mastodon* and *Dinotherium*, but if the tooth on which my observations are based be complete, it is distinct from either. The possession of only two transverse crests separates it from the former, and would, were the tooth an anterior molar, refer it to the latter. As it appears to be a posterior molar, this view of its affinity becomes untenable, and I therefore establish for it a new genus, under the name *CÆNOBASILEUS*. The tooth described resembles that of the genus *Tapirus*, but differs in the absence of the external trihedral enlargement of the cross crests seen in the superior molars of the former, and also in the tubercular and fissured character of the crests proper. The species may be called *C. tremontigerus*.

The typical specimen was probably obtained in Texas, but I am not yet informed as to the precise locality.

## CONTRIBUTIONS FROM THE LABORATORY OF THE UNIVERSITY OF PENNSYLVANIA.

### No. VIII.

#### *On the Composition of the Natural Gas from certain Wells in Western Pennsylvania and New York.*

BY SAMUEL P. SADTLER.

(*Read before the American Philosophical Society, March 2, 1877.*)

In February, 1876, I read before this Society a paper giving some results obtained in the analysis of the natural hydrocarbon gases of Western Pennsylvania. The material examined at that time consisted of the gases from the Burns Well and the Harvey Well in Butler Co., from the Rogers Well in Westmoreland Co., and the Cherry Tree Well in Indiana Co.

During the past summer I was again engaged in the service of the Second Geological Survey of the State, and spent a month in the Oil regions of Pennsylvania. While on this trip I collected six new lots of natural gases and have recently completed my examination of them.

These gases were the following :

1. A new sample from the Harvey Well in Butler County. This was taken as in the previous case from the delivery pipe in Spang, Chalfant & Co.'s Mills at Ætna, Alleghany County, Pa. An interval of nine months had elapsed and I wished to see if any differences in its chemical composition could be made out as having occurred in the meantime.

2. From a Well near Sheffield Station on the Philadelphia and Erie

R. R. in Warren County. This well had yielded only a trifling amount of oil but from it came a terrific outburst of gas. The geological horizon was totally different from that of the gas-wells in Butler County, being at least 600 feet lower. The gas had been used for some time to light the town of Sheffield and the tanneries there, being conveyed in pipes some two miles for that purpose.

3. From a Well some five miles from Wilcox Station on the Philadelphia and Erie R. R. in McKean County. Two wells had been sunk in this neighborhood for oil and both had yielded gas only. The geological horizon here is again different being some 400 or 500 feet lower than that of the Sheffield Well. The gas is not utilized at present.

4. From one of the gas wells at Erie, Pa. Quite a number of wells have been sunk at different times in the city of Erie, and the gas obtained has been utilized as fuel in the manufactories there. The specimen taken was from a well sunk by Oliver Bacon & Co., and the gas was used by them as fuel for their flour mills. This gas is again from a distinct geological horizon.

5. A specimen taken from the old well at Fredonia, N. Y., which has supplied the town of Fredonia for a number of years with a natural illuminating gas, was taken for analysis and comparison with those from the Pennsylvania localities. This gas is from a depth of 100 feet only.

6. A specimen was also taken from a new Well at Fredonia, which is now used for purposes of illumination. This gas comes from a depth of 1200 feet.

These gases were all collected, as in the previous cases, in glass tubes which were sealed before the mouth blow-pipe, while a current of the gas was still passing through them.

I will present with these new analyses those of the other gases published in my former paper. This is chiefly for the purpose of comparison. For this same reason I have classified the gases in several groups according to their geographical location.

#### *I. Gases from the Lower Oil Fields.*

1. Burns Well in Butler County. Collected in November, 1875.
2. Harvey Well in Butler County. Collected in November, 1875.
3. Gas from the same Well. Collected in August, 1876.
4. Rogers Well in Westmoreland County. Collected in November, 1875.

	1.	2.
Carbonic Acid ( $\text{CO}_2$ ).....	.34	.66
Carbonous Oxide ( $\text{CO}$ ).....	trace	trace
Ethylene series ( $\text{C}_2\text{H}_4$ ) .....	—	—
Hydrogen ( $\text{H}$ ).....	6.10	13.50
Marsh-gas ( $\text{CH}_4$ ) .....	75.44	80.11
Ethyl-hydride ( $\text{C}_2\text{H}_6$ ).....	18.12	5.72
Propyl-hydride ( $\text{C}_3\text{H}_8$ ) .....	trace	trace
Oxygen ( $\text{O}$ ).....	—	—
Nitrogen ( $\text{N}$ ).....	—	—
	100.00	99.99

	3.	4.
Carbonic Acid.....	.71	.35
Carbonous Oxide.....	.24	.26
Ethylene series.....	.06	.56
Hydrogen.....	5.60	4.79
Marsh-gas.....	85.40	89.65
Ethyl-hydride.....	7.96	4.39
Propyl-hydride.....	trace	trace
Oxygen.....	.03	—
Nitrogen.....	—	—
	<hr/> 100.00	<hr/> 100.00

## II. *Gases from Warren and McKean Counties.*

1. Sheffield Well in Warren County. Collected in August, 1876.
2. Wilcox Well in McKean County. Collected in August, 1876.

	1.	2.
Carbonic Acid.....	.09	.02
Carbonous Oxide.....	.24	.15
Ethylene series.....	—	.62
Hydrogen.....	3.12	7.55
Marsh-gas.....	78.42	62.37
Ethyl-hydride.....	18.00	29.29
Propyl-hydride.....	trace	trace
Oxygen.....	.13	—
Nitrogen.....	—	—
	<hr/> 100.00	<hr/> 100.00

## III. *Gases from the Lake Erie border in Pennsylvania and New York.*

1. Erie gas from Erie, Pa. Collected in August, 1876.
2. Older Fredonia Well. Collected in August, 1876.
3. Newer Fredonia Well. Collected in August, 1876.

	1.	
Carbonic acid.....	.30	
Carbonous oxide.....	.61	
Ethylene series.....	—	
Hydrogen.....	.43	
Marsh-gas.....	40.33	} 98.59 {
Ethyl-hydride.....	58.26	
Propyl-hydride.....	trace	
Oxygen.....	.07	
Nitrogen.....	—	
	<hr/> 100.00	

100.00

	2.		3.
Carbonic acid.....	.44		.28
Carbonous oxide.....	.84		.22
Ethylene series.....	.42		.47
Hydrogen.....	8.56		7.49
Marsh-gas.....	40.83	89.73 {	65.28
Ethyl-hydride..	48.90		26.99
Propyl-hydride..	trace		64.56
Oxygen.....	—		91.55
Nitrogen.....	—		trace
	99.99		100.01

The hydrocarbons of the Marsh-gas series in these three analyses can be counted together with perfect accuracy as 98.59 per cent., 89.73 per cent., or 91.55 per cent. respectively, or we have a choice of two methods of reckoning the individual amounts, with proximate accuracy however only. In these analyses the second method of estimation, viz: that dividing the amount between marsh-gas and propyl-hydride appears the more probable.

#### IV. Gas from Indiana Co. Pa.

1. Cherry Tree Well. This gas bubbles through a spring of fresh water and had to be collected over water. The totally different circumstances of its occurrence will explain in part the differences in composition. The geological horizon is much higher than that of any other gases analysed. It was collected in November, 1875.

	1.
Carbonic Acid.....	2.28
Carbonous oxide.....	—
Ethylene series.....	—
Hydrogen.....	22.50
Marsh-gas.....	60.27
Ethyl-hydride.....	6.80
Propyl-hydride.....	—
Oxygen.....	.83
Nitrogen.....	7.32
	100.00

A casual examination of these figures with a reference to the approximate geological horizon in each case will show several well-marked peculiarities. The Cherry Tree gas which comes from the highest geological horizon, is found to contain 22.50 per cent. of hydrogen and 60.27 per cent. of marsh-gas. This would make it the lightest of any of the gases analysed.

The four from the next lower geological horizon, *i. e.*, the Butler Co., oil-fields, show an advance upon this, and are quite similar, with two somewhat anomalous features showing, however—the 18.12 per cent. of

ethyl-hydride in the Burns Well gas and the 13.50 per cent. of hydrogen in the first sample of the Harvey Well gas. The gas from the Warren Co. geological horizon—obtained at the Sheffield Well—is very similar to the gas of the Burns Well in Butler Co.

The gas from the McKean Co. geological horizon—obtained at the Wilcox Well—is distinctly different from any of those preceding it. The 29.29 per cent. of ethyl-hydride makes it a heavier gas.

The three gases from the Lake Erie border however show the greatest differences. The per cent. of ethyl-hydride in these three analyses exceeds the per cent of marsh-gas, so that it becomes reasonable to estimate some of these heavy hydrocarbons as propyl-hydride. These three gases would be the heaviest of all those examined. An experimental determination of the specific gravity of the Erie gas made by the diffusion method gave .894. The specific gravity as calculated from the analysis was .845.

I will append several analyses of similar natural hydrocarbon gases that have come to my hand.

1. From a gas-well at West Bloomfield, N. Y. Analysed by Prof. Henry Wurtz. (Silliman's Journal (2) XLIX p. 336.)
2. From the Neff gas-well near Gambier, Knox Co. Ohio. Analysed by Prof. E. W. Morley, Hudson, Ohio. (Private communication.)
3. From a so-called "burning-spring" at St. Barthelemy, Isère, France. Analysed by F. M. Raoult. (Wagner's Jahresbericht 1870, p. 704.)

	1.	2.	3.
Carbonic acid.....	10.11	0.3	0.58
Carbonous oxide.....	—	0.5	—
Ethylene series.....	2.94	—	—
Hydrogen.....	—	—	—
Marsh-gas.....	82.41	81.4	98.81
Ethyl-hydride....	—	12.2	—
Oxygen.....	0.23	0.8	0.10
Nitrogen.....	4.31	4.8	0.48
	<hr/>	<hr/>	<hr/>
	100.00	100.00	99.97

In analyses No. 1 and No. 3, probably no attempt was made to distinguish between marsh-gas and Ethyl-hydride, and the figures given for marsh-gas probably express the sum of the marsh-gas hydrocarbons.

A description of the absorption tests by which I proved the presence of ethyl-hydride and propyl hydride and an explanation of the formulas by which the results of the gas-analyses were calculated appeared in my previous paper. (Vol. XVI, No. 97 of the Proceedings of the Am. Phil. Soc.; also reprinted in American Chemist for Sept. 1876).